

Fig. 1 (cont'd).

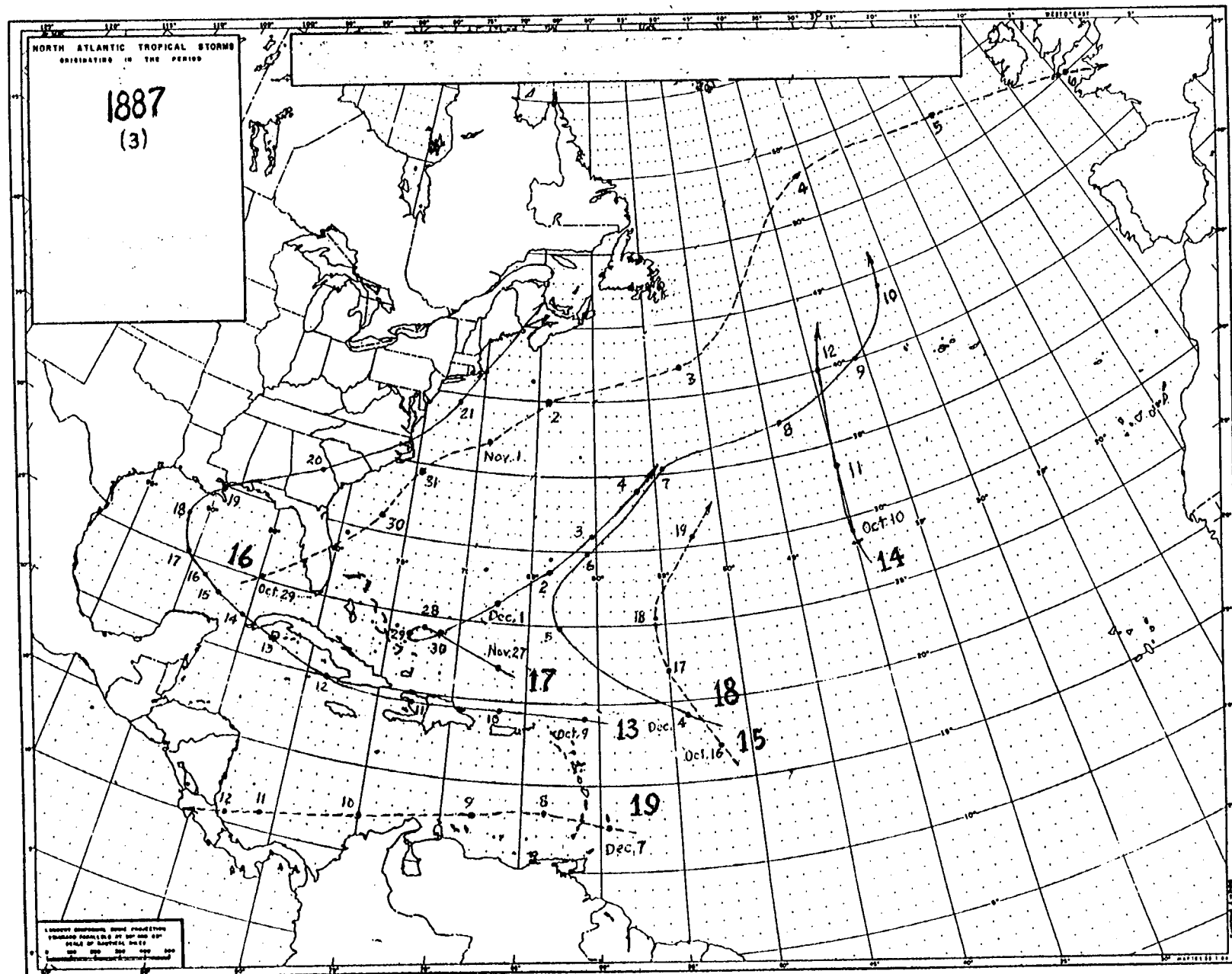


Fig. 1 (cont'd).

Lowest barometer readings of 28.74 inches at Point Isabel (item 7) and 28.93 inches at Brownsville (item 8) were found to justify the hurricane status given to the storm in Neumann et al. (1993) under the label of Storm 7, 1887.

Storm 10, 1887 (Sept. 15-18), H.

This storm corresponds to Storm 8, 1887 in Neumann et al. (1993).

The following information was found about this storm: 1) Storm of Sept. 15-18, 1887. Far out in the Atlantic (Tannehill, 1938). 2) This system was of tropical origin and moved northward in the vicinity of the 55 degrees W. meridian during Sept. 15 and 16, attained by storms of hurricane force. During Sept. 17 the center passed E. of N. over the Banks of Newfoundland and during Sept. 18 moved N. of the 50 degrees N. parallel and beyond the area of observations (Monthly Weather Review, Sept. 1887). 3) Steamship "Marsala" reported a strong gale on Sept. 16 and 17; wind veered from S.E. to N.W.; lowest barometer 29.02 inches at 9 P.M. Sept. 17 in lat. 45 26 N., long. 50 54 W. (Monthly Weather Review, Sept. 1887). 4) Mr. J. Higgins, the observer at Saint John's, Newfoundland, stated that a strong N.E. gale, with heavy rain, commenced there in the afternoon of Sept. 17; at 11 P.M. barometer fell to 29.31 inches; gale increased and continued till the morning of Sept. 18, when it veered to N.W. and moderated (Monthly Weather Review, Sept. 1887). 5) St. John's, Newfoundland, Sept. 19. A gale from the N.E. Saturday night (Sept. 17) caused much damage at Portugal Cove. Many vessels were driven ashore and others were driven against the cliffs and smashed. At Placentia, several craft were driven seaward and have not since been heard from. Bonavista presents a dreadful scene (The New York Times, Sept. 20, 1887, p.1, col.5). 6) Map showing a track for this storm. Positions along the track are: Sept. 15, lat. 28 N., long. 55.3 W.; Sept. 16, lat. 33 N., long. 58 W.; Sept. 17, lat. 43 N., long. 52.7 W.; Sept. 18, lat. 50 N., long. 50 W. (Monthly Weather Review, Sept. 1887). Author's note: A similar track is included in Mitchell (1924).

The above items suggested some modifications to be introduced along the track shown in Neumann et. al. (1993) as for Storm 8, 1887. The author of this study kept unchanged the 7 A.M. Sept. 15 position in the just mentioned publication, and produced new 7 A.M. position estimates as follows: Sept. 16, near 34.0 degrees N., 55.3 degrees W., primarily based on interpolation, along a smooth curve, between positions on the previous day and the next day; Sept. 17, near 41.0 degrees N., 53.5 degrees W., using space-time continuity as applied backwards on the basis of items 3) and 4); Sept. 18, near 50.0 degrees N., 48.0 degrees W., based on splitting the difference between positions in item 6) and in Neumann et al. (1993), after having taken into account the wind information given in item 3). The author's track for Storm 10, 1887 is displayed in Fig. 1.

General information in item 2) and the barometer reading of 29.02 inches reported by the "Marsala" (item 3) were found to support the hurricane status that Neumann et al. (1993) attributed to this storm (Storm 8, 1887 in their publication).

Storm 11, 1887 (Oct. 6-8), T. S.

This storm corresponds to Storm 9, 1887 in Neumann et al. (1993).

Information about this storm was found to be rather limited: 1) This system is traced from the Caribbean westward along the 20 degrees N. parallel over Yucatan and the southern portion of the Gulf of Mexico during Oct. 6-8, its path being determined, approximately, by a limited number of vessel reports. While the cyclonic nature of this storm is well defined by chartered reports, its course was too far southward to accurately determine its strength (Monthly Weather Review, Oct. 1887). 2) Storm of Oct. 6-8, 1887. Yucatan (Tannehill, 1938). 3) Map showing a storm track with the following daily positions: Oct. 6, lat. 19.5 N., long. 85.5 W.; Oct. 7, lat. 19.5 N., long. 89.7 W.; Oct. 8, lat. 19.7 N., long. 95.0 W. (Monthly Weather Review, Oct. 1887). Author's note: A similar track for this storm is included in Mitchell (1924).

The information in the above items was found to support, in general, the track in Neumann et al. (1993) as for Storm 9, 1887. Therefore, such a track is reproduced in Fig. 1 as for Storm 11, 1887.

Because of the uncertainties about the storm strength discussed in item 1), the author of this study believes that the classification of the system as a tropical storm given in Neumann et al. (1993) is appropriate and, therefore, it was kept unchanged.

Storm 12, 1887 (Oct. 8-9), T. S.

This storm seems to be somewhat related to Storm 10, 1887 in Neumann et al. (1993) in the sense that some information allegedly connected to this system appeared to have been used in preparing the track for such a storm.

The following information was found to be allegedly related to the storm: 1) The presence of this depression over the Caribbean Sea was shown on reports on Oct. 8; by Oct. 9 the storm center had apparently moved westward to about 19 degrees N., 71 degrees W. (it should read 81 degrees W.) and on the morning of Oct. 10 it had moved N.W., over the western extremity of Cuba, whence it passed slowly westward over the Gulf of Mexico. The path subsequent to Oct. 11 could not be determined, owing to absent reports E. of the position it occupied on that date (Monthly Weather Review, Oct. 1887). 2) Steamship "Alvena". Oct. 8, between Maysi (Cuba) and Castle Island, at 4:57 A.M., Greenwich time; 8:12 A.M., barometer 29.63 inches and falling rapidly; 9:37 A.M., barometer lowest 29.36 inches after which it commenced to rise. The weather during this time was heavy and threatening, with wild-looking clouds from N. to S. and around to W.; at the last-mentioned hour clouds parted in E. to N. and the greater portion remained in the S., but no rain fell. Oct. 9, between lat. 25 10 N., long. 74 08 W. and lat. 28 N., long. 74 15 W.; at 4:50 A.M., Greenwich time, a fresh gale commenced, with heavy rain and a rough sea from E.; gale continued until 7 P.M., when it moderated; lowest barometer 29.59 inches at 9 A.M. (Monthly Weather Review, Oct. 1887). Author's note: Castle Island is located in the southeastern Bahamas. 3) Havana, Oct. 10,

barometer 29.89 inches, wind S.E. 11 mph; cloudy weather, 4 tenths of cirrostratus clouds moving from the S.W.; storm center west of station (Monthly Weather Review, Oct. 1887). Author's note: In the author's opinion, the above mentioned weather conditions at Havana do not seem to imply the presence of the storm center which was stated to have been to the west of that city. 4) Storm of Oct. 9-10, 1887. Western Cuba (Tannehill, 1938). 5) Brownsville, Tx., Oct. 11. Reports of another hurricane in the Gulf moving westward create great uneasiness here. Seven inches of rain fell last night and the Rio Grande River is higher than ever. In Matamoros the flood has spread greatly. The steamer "Aransas" has been 2 days on the bar, unable to communicate with the town on account of the rough weather (The New York Times, Oct. 12, 1887, p.5, col.4). Author's note: The bad weather in the Brownsville area was probably linked in some way to Storm 11, 1887. 6) Storm track showing the following positions: Oct. 9, 19 degrees N., 80.5 degrees W.; Oct. 10, 22.7 degrees N., 85.0 degrees W.; Oct. 11, 23.3 degrees N., 87 degrees W. (Monthly Weather Review, Oct. 1887). Author's note: A similar track is included in Mitchell (1924) and it should be indicated that the track in Neumann et al. (1993) as for Storm 10, 1887 does not differ significantly from the above mentioned tracks.

The author of this study believes that the track displayed in Neumann et al. (1993) is primarily based on the tracks discussed in item 6) and its corresponding author's note. In turn, these latter tracks appeared to have been based, primarily, on information in item 3) which, in the author's opinion, looks to have been erroneous as far as to justify the presence of a storm to the W. of Havana on Oct. 10. In support of the author's opinion is the fact that in neither the catalog of Cuban cyclones by M. Gutierrez-Lanza (Sarasola, 1928) nor the Cuban cyclone chronology by Martinez-Fortun (1942) there is an indication of any storm to have affected Cuba on Oct. 9-10, 1887. However, information in item 2) was found to support, indeed, a storm over the southeastern Bahamas and adjacent waters on Oct. 8 and 9 which, according to the above mentioned publications on Cuban cyclones, it did spare the island of Cuba. Therefore, the author of this study decided to discard the storm track in Neumann et al. (1993) as for Storm 10, 1887 and to introduce a new track for the storm over and near the Bahamas by making use of information in item 2). Author's 7 A.M. estimated positions were as follows: Oct. 8, 21.7 degrees N., 74.3 degrees W.; Oct. 9, 25.5 degrees N., 75.0 degrees W. After the "Alvena" was near the center of the storm at 9:27 A.M. Oct. 8 (Greenwich time), both the ship and the storm progressed northward, resulting in the E. gale reported by the "Alvena" for about 14 hours on Oct. 9 (item 2). The author's track for this weather system over and near the Bahamas is introduced as for Storm 12, 1887 in Fig. 1. The author was unable to track the storm beyond Oct. 9. However, it seems possible, and even likely, that this storm might have turned northeastward, being the same depression that the Monthly Weather Review, Oct. 1887, mentioned to have been to the E. of Bermuda on Oct. 12.

As there is no evidence of hurricane winds associated with Storm 12, 1887, a tropical storm status was given to this weather system.

Storm 13, 1887 (Oct, 9-21), H.

This is the same storm that Neumann et al. (1993) identify as Storm 11, 1887.

The following information was found in relation to this storm:

1) Storm of Oct. 9-24, 1887. Recurved in the Gulf (Tannehill, 1938). 1) Corvette "Nalon", from Belize to Cienfuegos. Oct. 10, lat. 19 50 N., long. 75 20 W., heavy sea from E.S.E., heavy clouds in S.E. quadrant, wind oscillating from E.S.E. to S.E., barometer falling slowly. Oct. 11, in the morning, wind hard from E.S.E., heavy clouds and violent gusts of rain and wind; in the afternoon, the barometer fell considerable, to 29.33 inches at 6 P.M., weather dark and continuous rain; 8 P.M., terrible rolling sea from E.S.E. to S.S.W.; during the night, continuous rain and violent gusts, barometer fell to 29.21 inches. Oct. 12, in the morning, rain continued with hurricane from S.E. to S., the sea a boiling mass and so it continued to the end of the day's run in lat. 20 45 N., long 77 W. (?) with barometer steady at 29.21 inches; in afternoon, much rain and wind, sea more moderate; 6 P.M., weather cleared somewhat and barometer rose; during night violent gusts from S. and S.S.W. Oct. 12 (it should probably read Oct. 13), noon, in lat. 20 50 N., long. 76 30 W., barometer rising slowly to 29.29 inches, hard gusts. Oct. 13, hard S.W. gusts at long intervals, sea from E.S.E. and diminishing, barometer rising (Monthly Weather Review, Oct. 1887). Author's note: The positions given for Oct. 12 and 13 are obviously wrong because they are over land. In addition, some of the barometer readings might be unreliable and the Belize-Cienfuegos sailing seems questionable. 3) Cienfuegos, Oct. 12, 3 P.M., barometer 29.70 inches, S.E. wind, heavy rain, violent gusts (Monthly Weather Review, Oct. 1887). 4) Trinidad and Santa Cruz, violent gales from S.E., light rain, sea swell S.S.E. (Monthly Weather Review, Oct. 1887). Author's note: Although no date is given, these observations from Trinidad and Santa Cruz (del Sur), which are both located on the southern coast of Cuba, were probably taken on Oct. 12. 5) Havana, Oct. 12, 9 A.M., barometer 29.74 inches, wind E. 10 mph, light rain; 3 P.M., barometer 29.64 inches, wind E. 20 mph, heavy rain; Oct. 13 (no time given, but probably in the morning), barometer 29.69 inches, wind E. 25 mph., light rain; Oct. 14, 6 A.M., barometer 29.70 inches, wind S.E. 19 mph., cloudy (Monthly Weather Review, Oct. 1887). 6) Steamship "Neuces" reported a strong gale from Oct. 13 to 15; wind veered from N.N.E. to E.N.E.; lowest barometer 29.73 inches at noon Oct. 14 in lat. 24 50 N., long. 85 03 W.. After the gale, the wind continued to flow from E.S.E., accompanied by heavy rain squalls to Key West (Monthly Weather Review, Oct. 1887). 7) Steamship "Mascotte" reported a whole gale on Oct. 14 and 15, wind veered from N.E. to S.E., lowest barometer 29.68 inches at 1 A.M. Oct. 15 in lat. 29.68 N., long. 82 20 W. (Monthly Weather Review, Oct. 1887). 8) Oct. 12-15, 1887. Extensive cyclone whose center passed S. of the island of Cuba and moved across Pinar del Rio. It affected the four westernmost provinces with torrential rains and great flooding, particularly in Vuelta Abajo and El Roque; winds were moderate (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban cyclones by M. Gutierrez-Lanza which is included in Sarasola (1928). 9) New

Orleans, La. Moving approximately northeastward towards the mouth of the Mississippi River, the disturbance approached the Louisiana coast with cyclonic energy and reached the vicinity of New Orleans on the morning of Oct. 19. A barometer reading of 29.22 inches, 0.82 inches below normal, was reported in that station, which represented a fall of 0.52 inches in eight hours. Passing to the S.E. of New Orleans, the center of the storm moved N.E. into Alabama on Oct. 19. At New Orleans the maximum wind velocity was 42 mph from the N. at 8:35 and 8:45 A.M. and the wind storm ended at 3:17 P.M. (Monthly Weather Review, Oct. 1887). 10) Pensacola Fl. A heavy gale prevailed during Oct. 19, maximum velocity 48 mph from S.W. (Monthly Weather Review, Oct. 1887). 11) On Oct. 19, winds up to 40 mph were reported at Galveston and up to 50 mph were reported at Mobile (Monthly Weather Review, Oct. 1887). 12) Galveston, Oct. 18. A light N.E. wind which set in here yesterday grew to a brisk gale this morning and as the hours advanced the gale increased until it reached 49 mph. At 10 A.M. the bay was very rough but no damage has been reported (The New York Times, Oct. 19, 1887, p.5, col.2). 13) New Orleans, Oct. 19. The heaviest rain of the year fell yesterday and the barometer reached the lowest point that is on record since the establishment of the Signal (Service) station here. It rained all day, making a total of 4.50 inches (The New York Times, Oct. 20, 1887, p.1, col.2). 14) New Orleans, Oct. 20. News of damage by the recent storm indicated that the steamer "Whitney", which sailed for Veracruz on Tuesday, encountered the hurricane. The tugboat "Minnie Woods" was sunk at quarantine station. The storm blew down a water tank 60 feet high at Magnolia station (The New York Times, Oct. 21, 1887, p.2, col.3). 15) Bark "Adele Sabina" reported a storm on Oct. 19 and 20; wind veered from E.S.E. to W.N.W.; lowest barometer 29.35 inches at 1 P.M. Oct. 19 in lat. 30 08 N., long. 87 10 W. (Monthly Weather Review, Oct. 1887). 16) Bark "Gettysburg" reported a storm on Oct. 19; wind veered from S.E. to W.; lowest barometer 29.38 inches at 11 A.M. in lat. 29 55 N., long. 87 10 W. (Monthly Weather Review, Oct. 1887). 17) The low pressure progressed northeastward towards the coast of North Carolina which it reached in the evening of Oct. 20. Trending afterwards more to the N., it passed with increased energy into the Atlantic and, moving adjacent to the coast, crossed southeastern Massachusetts and entered New Brunswick, where it joined on the evening of Oct. 21 with another pressure area (Monthly Weather Review, Oct. 1887). 18) New York, Oct. 21. The cyclone that has played havoc in the South was off Virginia at 7 A.M. this morning (Monthly Weather Review, Oct. 1887). Author's note: The advertised position seemed to be too far south for 7 A.M. Oct. 21. 19) Block Island, R.I. Light and heavy rains prevailed during the forenoon up to 11:20 A.M. Oct. 21. High S.E. winds began during the early morning and, shifting to N. at 11:20 A.M., attained a maximum velocity of 40 mph from the last-mentioned direction (Monthly Weather Review, Oct. 1887). 20) Provincetown, Ma., Oct. 21. A heavy E. gale raged from midnight last night until noon today. Then the wind shifted suddenly to N.W., blowing heavily from that quarter for 2 hours and causing a heavy sea offshore. (The New York Times, Oct. 22, 1887, p.5, col.3). 21) Map showing a track for this storm. Daily positions along that track are as follows: Oct. 11, 15.5

degrees N., 78 degrees W.; Oct. 12, 18.3 degrees N., 81 degrees W.; Oct. 13, 20.3 degrees N., 82.3 degrees W.; Oct. 14, 21.5 degrees N., 83.7 degrees W.; Oct. 15, 22.5 degrees N., 89 degrees W.; Oct. 16, 22.5 degrees N., 89 degrees W.; Oct. 17, 23.7 degrees N., 96.7 degrees W.; Oct. 18, 27 degrees N., 95 degrees W.; Oct. 19, 30 degrees N., 90.5 degrees W.; Oct. 20, 33 degrees N., 82.5 degrees W.; Oct. 21, 41.5 degrees N., 71.5 degrees W. (Monthly Weather Review, Oct. 1887). Author's note: The track shows a big jump between positions for Oct. 16 and 17, bringing the storm center much closer to the Mexican coast than in the case of the track displayed in Neumann et al. (1993) as for Storm 11, 1887. 21) A second map containing a track for this storm which is very similar to the one in Neumann et al. (1993) as for Storm 11, 1887 (Mitchell, 1924).

Information contained in the above items suggested the need for some modifications to be introduced along the track in Neumann et al. (1993) as for Storm 11, 1887. Modifications were introduced for the period Oct. 11-15 and the track just mentioned was extended to Oct. 20 and 21. No changes were introduced along the track in Neumann et al. (1993) for the periods Oct. 9-10 and Oct. 16-19. The changes and additions which were introduced required new 7 A.M. position estimates by the author of this study as follows: Oct. 11, 19.5 degrees N., 72.7 degrees W., a slight adjustment to the W. aimed at obtaining a better space-time continuity along the track; Oct. 12, 20.0 degrees N., 78.7 degrees W., based on information in items 2) through 4) and on space-time continuity; Oct. 13, 21.5 degrees N., 82.7 degrees W., primarily based on item 5); Oct. 14, 22.5 degrees N., 85.3 degrees W., primarily based on item 6); Oct. 15, 23.3 degrees N., 87.5 degrees W., based on interpolation along a smooth curve between the author's position for 7 A.M. Oct. 14 and the 7 A.M. Oct. 16 position in Neumann et al. (1993); Oct. 20, 33.0 degrees N., 82.5 degrees W., based on information in item 21); Oct. 21, 39.5 degrees N., 72.0 degrees W., chiefly based on space-time continuity as applied backwards, using information in items 19) and 20). The author's track for Storm 13, 1887 is shown in Fig. 1.

Barometer readings of 29.21 inches reported by the "Nalon" (item 2) and of 29.22 inches recorded at New Orleans, both taken outside the center of the storm, were found to support the hurricane status given to it in Neumann et al. (1993) as for Storm 11, 1887.

Storm 14, 1887 (Oct. 10-12), H.

This is the same storm which Neumann et al. (1993) identify as Storm 12, 1887.

The following information was found about this storm: 1) The presence of a depression was shown to the N.E. of the Windward Islands in the morning of Oct. 9 and by Oct. 11 the storm had moved northeastward to lat. 30 N., long. 40 W., from which position it passed northward and united with another depression which had advanced S.E. from Newfoundland (Monthly Weather Review, Oct. 1887). 2) Storm of Oct. 11, 1887. Far out in the Atlantic (Tannehill, 1938). 3) Spanish ship "Navarro, Oct. 10, at night, fine weather, steady W. wind; light clouds moving swiftly from S.,

growing heavier and the wind shifting to the third quadrant; Oct. 11, lat. 34 N., long. 40 20 W. at noon; during the early morning the barometer fell rapidly, with wind S.E. and E.S.E. and violent gusts, and high sea from S.W. and heavy rain. At 7 A.M. the wind was furious from E.N.E., with heavy rain and enormous seas from the second and third quadrants; 8:30 A.M., wind N.E., blowing with terrible fury, sea confused from third, second and first quadrants, being more pronounced from S.W.; 9:30 A.M. wind N.N.E. with terrific squalls, intervals of calm and barometer oscillating between 28 and 29 inches; 11:30 A.M., barometer rising rapidly (Monthly Weather Review, Oct. 1887). Author's note: This extract from the ship's log was furnished by Rev. Benito Vines, S.J., director, Belen Meteorological Observatory, Havana, Cuba. 4) Steamer "Aldanach". Oct. 11, noon, lat. 37 20 N., long. 38 23 W., strong S.W. gale and a very heavy sea, barometer 29.49 inches and very unsteady; 4 P.M. wind increasing to about force 10, low stratus and nimbus clouds moving rapidly from W.S.W., barometer falling; 6 P.M., wind suddenly shifted to W. and blew with hurricane force, causing a fearful sea; continued blowing at about force 12 for 4 hours and commenced to moderate at 10 P.M. During the storm the lowest barometer reading was 29.20 inches and was not so unsteady as at noon; the clouds were very low stratus and were travelling very rapidly from the W. The storm seemed to occupy a small area, as previous observations showed fine weather and the same prevailed after the storm's passage (Monthly Weather Review, Oct. 1887). Author's note: The above extract was also furnished by Father Vines of Havana. The S.W. and W. winds and the cloud direction from the W. reported at all times seemed unreliable. 5) Steamship "Ocean Prince" reported a storm on Oct. 11 and 12, which backed from S.E. to E., N.E. and N.N.W., blowing hardest from N.N.W.; lowest barometer at 7:30 P.M. Greenwich time in lat. 38 07 N., long. 41 55 W. (Monthly Weather Review, Oct. 1887). 6) Storm track showing the following positions: Oct. 9, 19 degrees N., 57 degrees W; Oct. 10, 24 degrees N., 54 degrees W.; Oct. 11, 30 degrees N., 40 degrees W.; Oct. 12, 45 degrees N., 39 degrees W., merged with the Newfoundland storm (Monthly Weather Review, Oct. 1887). 7) Map showing a one-day, S.E.- N.W. oriented track passing through lat. 31 N., long. 42 W. (Mitchell, 1924).

Positions along the track in Neumann et al. (1993) for 7 A.M. Oct. 10 and for 7 A.M. Oct. 12 (Storm 12, 1887 in their publication) were accepted because they could not be verified in the light of the observations in the above items. However, their 7 A.M. Oct. 11 position was adjusted eastward by about 80 miles to 33.5 degrees N., 40.0 degrees W., primarily based on a careful analysis of the observations in item 3). The author's track for Storm 14, 1887 is displayed in Fig. 1.

The hurricane status that Neumann et al. (1993) gave to this storm was fully supported by the information contained in items 3) through 5).

Storm 15, 1887 (Oct. 16-19), T. S.

This storm corresponds to Storm 13, 1887 in Neumann et al. (1993).

Very limited information was found about this storm: 1) This storm apparently originated in the tropics , east of the 50 degrees W. meridian and by Oct. 16 was central in about 17 degrees N., 52 degrees W., whence it moved slowly to the N.W. to the 25 degrees N. parallel by Oct. 18. During the next 24 hours the center recurved northeastward. No special reports have been received relative to this storm and the scarcity of simultaneous observations from the region throughout which it passed renders it impossible to determine its strength (Monthly Weather Review, Oct. 1887). 2) Map showing a track for the storm. Daily positions are as follows: Oct. 16, 17 degrees N., 52 degrees W.; Sept. 17, 22 degrees N., 54 degrees W.; Oct. 18, 25 degrees N., 56 degrees W.; Oct. 19, 30 degrees N., 54 degrees W. (Monthly Weather Review, Oct. 1887). Author's note: A similar track is included in Mitchell (1924).

The track in Neumann et al. (1993) was not found to differ greatly from those in item 2) and its corresponding author's note. Therefore, the track for Storm 13, 1887 in Neumann et al. (1993) was accepted without any modification and reproduced as for Storm 15, 1887 in Fig. 1.

The uncertainty about the storm intensity discussed in item 1) seemed to justify the tropical storm status given in Neumann et al. (1993) as for Storm 13, 1887. Therefore, the author of this study decided to keep that status for Storm 15, 1887.

Storm 16, 1887 (Oct. 29- Nov 6), T. S.

This is the same storm that Neumann et al. (1993) identify as Storm 14, 1887.

The following information was found about this storm: 1) Storm of Oct. 29- Nov. 9. Gulf, over Florida to Atlantic (Tannehill, 1938). 2) Storm of Oct. 29, 1887. S.W. Florida. Minor (Dunn and Miller, 1960). 3) The low pressure area was approximately located off the southwestern coast of Florida, about 200 miles to the N.W. of Key West, on the morning of Oct. 29. Crossing the Florida peninsula during the next 8 hours the center of the disturbance trended more to the N. and, moving approximately parallel to the coast and at a comparatively short distance from it, progressed northeastward (Monthly Weather Review, Oct. 1887). 4) In the vicinity of Norfolk, Va., the storm seemed to have been especially severe on Oct. 31 and to have caused much general damage. On the afternoon that day its energy was perhaps at its maximum and the pressure was then 0.56 inches below normal at Norfolk, where the northerly gale prevailed throughout the day, attaining a maximum velocity of 40 mph from the N.E. At Hatteras, N.C., the storm began at 4:05 A.M. and ended at 2:20 P.M. Oct. 31; a maximum velocity of 54 mph was recorded from the N. at 4:22 A.M. At Kittyhawk, N.C., rainy and brisk N. winds became high with a maximum velocity of 60 mph at 10:15 P.M. Oct. 30. At Raleigh, N.C., a heavy rain storm began during the night of Oct. 30-31 and continued until 1:10 P.M. when hail fell for about 10 minutes. It again turned to heavy rain and was accompanied by snow from 6:30 to 8:30 P.M. (Monthly Weather Review, Oct. 1887). 5) Steamship "Claribel" reported a whole gale with squalls of hurricane force from Oct. 30 to Nov. 1; wind veered from N.N.E. to S.E. and backed again to N.E.; lowest barometer

29.35 inches at 4 P.M. Oct. 31 in lat. 37 N., long 74 W. (Monthly Weather Review, Oct. 1887). 6) Brig "Lilian" reported that on Oct. 30, the wind blew heavily from the N.E. and E.N.E. with heavy rain and lightning; Oct. 31, wind lulled and hauled to S.E. and S., blowing hardest from the S.S.W.; lowest barometer 29.44 inches from sundown to midnight (Oct. 31- Nov. 1) in lat. 35 30 N., long. 74 30 W. (Monthly Weather Review, Oct. 1887). 7) Barkentine "Jose E. More" reported a whole gale from Oct. 30 to Nov. 2; wind veered from N.E. to S.W. and N.W.; lowest barometer 29.39 inches at 4 P.M. Oct. 31 in lat. 35 26 N., long. 75 10 W. (Monthly Weather Review, Oct. 1887). 8) Steamship "Edith Godden" reported a whole gale on Oct. 30 and 31; wind veered from N.E. to E. and to S. by W.; lowest barometer 29.32 inches at noon Oct. 31 in lat. 35 54 N., long. 73 10 W. (Monthly Weather Review, Oct. 1887). 9) Ship "Camalia" brought to this port the captain and crew of brig "Osseo" which had sailed from New York for Trinidad on Oct. 30. Nothing unusual happened until Tuesday (Nov. 1) when she was struck by a terrific hurricane accompanied by a heavy and angry sea. The storm lasted over 12 hours. Decks were started and floods of water began to come in. The pumps were manned but there was soon 4 feet of water in the hold. That night the gale abated somewhat and there was a small hope the brig keeping up more than a few hours at best. On Wednesday (Nov. 2) the storm began to rage again with great fury and a big wave carried away both boats. Then the "Camalia", which took the crew, was sighted (The New York Times, Nov. 8, 1887, p.8, col.2). 10) The steamship "Wyonoka" left Norfolk Tuesday morning (Nov. 1) at 6 A.M. for New York. It was very stormy. At 9 A.M. saw a green object on the ocean about 6 miles from the ship. The wind was blowing fiercely and the sea was running high up on decks. It happened to be the sunken wreck of a schooner with 5 sailors lashed to the masts and ropes. They were rescued by the "Wyonoka" (The New York Times, Nov. 3, 1887, p.2, col.7). 11) From Nov. 1, the depression increased in energy until Nov. 5. when central W. of Ireland, after which it moved towards the E.S.E. into France (Monthly Weather Review, Nov. 1887). 12) Provincetown, Ma., Nov. 1. The heaviest "norther" of the season has been blowing along Cape Cod today, the wind reaching a velocity of 60 mph (Monthly Weather Review, Nov. 1887). 13) Steamship "Rhaetia" reported a storm from Nov. 2 to Nov.5; wind veered from S.S.W. to N.E.; lowest barometer 28.64 inches at 4 P.M. Nov. 3 in lat. 49 43 N., long. 50 56 W. (Monthly Weather Review, Nov. 1887). 14) Steamship "Egypt" encountered a S.S.W. to N.W. storm during Nov. 4 and 5; lowest barometer 29.19 inches at 4 P.M. Nov. 4 in lat. 50 36 N., long. 27 10 W. (Monthly Weather Review, Nov. 1887). Steamship "Australia" reported a storm on Nov. 5 and 6; wind veered from N. to S.; lowest barometer 29.23 inches at 3 A.M. Nov. 5 in lat. 49 30 N., long. 17 30 W. (Monthly Weather Review, Nov. 1887). 16) Map showing a track for this storm. Daily positions are: Oct. 29, 25.5 degrees N., 85.0 degrees W.; Oct. 30, 31.5 degrees N., 78.0 degrees W.; Oct. 31, 34.5 degrees N., 74.5 degrees W. (Monthly Weather Review, Oct. 1887). 17) A second map showing the continuation of the track after Oct. 31. Daily positions are as follows: Nov. 1, 37.0 degrees N., 69.0 degrees W.; Nov. 2, 40.0 degrees N., 64.0 degrees W.; Nov. 3, 42.0 degrees N., 52.0 degrees W.; Nov. 4, 53.0 degrees N., 36.0

degrees W.; Nov. 5, 53.0 degrees N., 19.0 degrees W.; Nov. 6, 50.0 degrees N., 4.0 degrees W. (Monthly Weather Review, Nov. 1887). 18) A third track which is not dramatically different from the combination of the ones above; however, this track is extended to Nov. 8, making the storm to have described a counterclockwise loop over and near northwestern France (Mitchell, 1924).

Information contained in the items above was found to support, in general, the track shown in Neumann et al. (1993) as for Storm 14, 1887. However, such a track extends only from Oct. 29 to Nov. 1 and information in items 11) through 15) and in items 17) and 18) clearly shows the continuation of the track for several days beyond Nov. 1. Therefore, 7 A.M. positions for the period Oct. 29-31 in Neumann et al. (1993), -as for Storm 14, 1887, were accepted and positions in item 17) for the period Nov. 1-6 were accepted as well. The accepted positions, which combine both tracks at the expense of sacrificing the 7 A.M. position for Nov. 1 in Neumann et al. (1993), were used by the author of this study in preparing the track which is displayed in Fig. 1.

Weather information for Raleigh, N.C., which is contained in item 4) clearly shows that the tropical phase of Storm 16, 1887 was quite short and that the storm should have become extratropical by Oct. 31, continuing as such thereafter.

The tropical storm status which Neumann et al. (1993) attributed to this storm (as for Storm 14, 1887) was found to be supported by the limited information available prior to Oct. 31.

Storm 17, 1887 (Nov. 27- Dec.4), H.

This is the same storm that Neumann et al. (1993) identify as Storm 15, 1887.

The following information was found in relation to this storm: 1) Storm of Nov. 27- Dec. 6, 1887. Described a loop in the Bahamas and turned northeastward into the Atlantic (Tannehill, 1938). 2) Steamship "Claribel". Nov. 28, passed Fortune Island, with winds increasing to heavy gale, high sea and frequent squalls. Gale continued from northward and westward blowing with hurricane force at times until Nov. 29, at noon, in lat. 24 N., long. 74 W., when wind shifted to N.E., with heavy cross sea; Nov. 30, noon, in lat. 26 N., long. 74 W., no abatement in either wind or sea, the latter being more to the northward, with heavy rain and wind squalls; towards midnight encountered 3 distinct seas, running from N., N.E. and N.W., those from N. and N.E. being dangerously high (Monthly Weather Review, Nov. 1887). Author's note: Fortune Island is a small island located in the Crooked I. Passage, southeastern Bahamas. 3) Ship "Fidelio" reported a strong N. by E. gale on Nov. 30; barometer lowest at 11 P.M. when in lat. 35 N., long. 68 W. (Monthly Weather Review, Nov. 1887). 4) Philadelphia, Dec. 10. Steamship "Benholm" (from Marbella). Dec. 2, off Bermuda, was struck by a heavy N.E. gale lasting 30 hours. High seas broke over the vessel doing slight damage above the decks (The New York Times, Dec. 11, 1887, p.1, col.4). 5) Bermuda: A heavy gale from N.E. to N. prevailed during Dec. 2 and 3 (Monthly Weather Review, Nov. 1887). 6) Steamship "Marsielle". Dec. 3, noon, lat. 29 N., long. 56 W.; 2 A.M. wind S.; later strong S.S.W. gale, heavy cross sea; Dec.

4, noon, lat. 29 N., long. 59 W.; S.S.W. gale increasing (Monthly Weather Review, Dec. 1887). 7) Track for this storm showing positions for Nov. 29 at 23 degrees N., 67 degrees W. and for Nov. 30 at 27.5 degrees N., 68.5 degrees W. (Monthly Weather Review, Nov. 1887). Author's note: The above positions were found to be in error. 8) A second track showing positions for Dec. 1 through Dec. 8. This track was started near 25 degrees N., 62 degrees W. and ended near 58 degrees N., 25 degrees W. (Monthly Weather Review, Dec. 1887) Author's note: The track is a continuation of the one in item 7). This track shows an essentially westward displacement from long. 56 degrees W. to long. 61.5 degrees W. at near lat. 35 N. from Dec. 4 to Dec. 5. 9) A third track, this one being similar to that in Neumann et al. (1993), but extending from Nov. 27 through Dec. 7 instead of through Dec. 4 (Mitchell, 1924). Author's note: This track appears to be the first one showing the loop described by the storm over the Bahamas which is mentioned in item 1) and which is also presented in Neumann et al. (1993) as for Storm 15, 1887.

The above information suggested some modifications to be introduced along the track in Neumann et al. (1993). Except for Nov. 27 and 28 and for Dec. 4, new 7 A.M. positions were estimated by the author of this study. Such positions primarily affected the timing along the track, with the exception that the new 7 A.M. Nov. 29 position resulted in a loop which was smaller and centered farther to the E. than the one in Neumann et al. (1993). The new 7 A.M. positions were as follows: Nov. 29, 23.7 degrees N., 73.5 degrees W., based on information in item 2); Nov. 30, 24.0 degrees N., 71.3 degrees W., based on space-time continuity along a smooth track; Dec. 1, 26.3 degrees N., 67.3 degrees W., also based on space-time continuity; Dec. 2, 28.5 degrees N., 63.5 degrees W., primarily based on information in item 5); Dec. 3, 31.0 degrees N., 60.3 degrees W., based on items 5) and 6). The above positions, as well as those which were kept unchanged in Neumann et al. (1993), allowed the author to prepare the track which is displayed in Fig. 1. The track was ended on Dec. 4 after having discarded a portion of the track mentioned in item 8) due to a suspicious westward displacement from Dec. 4 to Dec. 5.

The hurricane status which Neumann et al. (1993) attributed to this storm (as for Storm 15, 1887) was found to be supported by information in item 2). Therefore, the author of this study is accepting that status in spite of that Mitchell (1924) had previously indicated a doubtful hurricane intensity for this storm.

Storm 18, 1887 (Dec. 4-10), H.

This is the same storm that Neumann et al. (1993) identify as Storm 16, 1887.

The following information was found about this storm: 1) The depression was central to the eastward of the Lesser Antilles on Dec. 4, whence it moved N.W. to about lat. 25 N., long. 63 W. by Dec. 5. Recurving N. and N.E., the storm was traced to lat. 44 N., long. 32 W., after which it united with another weather system. This storm, in connection with the one in late Nov. and early Dec., was attended by a heavy "norther" over the West Indies during the

first four days of the month during which many vessels were wrecked (Monthly Weather Review, Dec. 1887). 2) On Dec. 4, during a violent gale, an immense wave struck the beach at Baracoa, Cuba, broke and flowed inland, destroying nearly 300 huts and houses without, however, an attendant loss of life (Monthly Weather Review, Dec. 1887). Author's note: The New York Times, Dec. 22, 1887, p.2, col.3, stated that the largest wave occurred at Baracoa on Dec.5 and not on Dec, 4. The newspaper said that the huge wave of Dec. 4 was the result of the blowing of a "norther" for 3 days and that on the previous day a small wave had washed the surface of the town (which is located on the northern coast near the eastern tip of Cuba) causing alarm but no damage. On Dec. 5 at 5 P.M., during the most violent wind, an immense wave was seen approaching, from which the people fled towards the hills. The wave struck the beach , broke and flowed inland, sweeping many huts and several good houses before it. After sweeping in 400 feet, the water flowed back to the ocean. It should be finally mentioned that Sarasola (1928) has wrongly stated that the disaster at Baracoa occurred on Nov. 3-5 instead of in early Dec. 3) Bark "Leocadia". Dec. 6 and 7, encountered a whole gale, veering from S.E. to N.W.; lowest barometer at 9 P.M. Dec. 6.in lat. 31 N., long. 56 W. (Monthly Weather Review, Dec. 1887). 4) Steamship "Kate Fawcett" reported a gale, attaining hurricane force on Dec. 7; position at noon: lat. 36 N., long. 51 30 W. (Monthly Weather Review, Dec. 1887). 5) Steamship "Orsino". Dec. 8, lat. 35 30 N., long. 46 W., had an increasing S.S.W. gale which veered to W.N.W. (Monthly Weather Review, Dec. 1887). 6) Steamship "Westergate". Dec. 9, had a terrific gale with squalls and tremendous cross seas; wind veered from S. to N.W.; position at noon: lat. 38 N., long. 37 30 W. (Monthly Weather Review, Dec. 1887). 7) Map showing a track for this storm. Positions are as follows: Dec. 4, 19 degrees N., 64 degrees W.; Dec. 5, 25 degrees N., 63 degrees W.; Dec. 6, 30 degrees N., 61 degrees W.; Dec. 7, 35.3 degrees N., 54.3 degrees W.; Oct. 8, 37 degrees N., 44 degrees W.; Dec. 9, 40 degrees N., 36 degrees W.; Dec. 10, 44 degrees N., 31.7 degrees W. (Monthly Weather Review, Dec. 1887).

Information contained in the above items was found to support, in general, the track in Neumann et al. (1993) as for Storm 16, 1887. Therefore, such a track is reproduced in Fig. 1 as for Storm 18, 1887.

The hurricane status which Neumann et al. (1993) attributed to this storm was found to be justified in the light of item 4).

Storm 18, 1887 should have gradually acquired extratropical characteristics as it moved towards high latitudes over the Atlantic.

Storm 19, 1887 (Dec. 7-12), T. S.

This storm corresponds to Storm 17, 1887 in Neumann et al. (1993).

The following information was found about this storm: 1) This system is given a probable westward track over the Caribbean Sea from Dec. 7 to Dec. 12, after which it apparently passed over Central America into the Pacific Ocean. During Dec. 7 and 8 a heavy

"norther", evidently occasioned by this depression, swept over the West Indies, causing much damage to shipping (Monthly Weather Review, Dec. 1887). 2) New York, Dec. 21. A steamer which has arrived here from Cape Haytien reported that heavy weather was experienced in the northern West Indies from Dec. 6 to 8, causing much damage along the coast. About 70 vessels were wrecked. A coasting steamer while endeavoring to make Cape Haytien capsized and 13 of her crew were drowned. The British schooner "Viola" was also damaged and 2 of her crew perished. H.M.S. gunboat "Wrangler" reached Turks Islands on Dec. 7, having stranded serious damage. About a dozen vessels have been stranded at Monte Christi (The Times, London, Dec. 22, 1887, p.5, col.4). 3) Map showing a track for this storm. Daily positions are as follows: Dec. 7, 12.7 degrees N., 59.7 degrees W.; Dec. 8, 13.5 degrees N., 64 degrees W.; Dec. 9, 13 degrees N., 68 degrees W.; Dec. 10, 11.7 degrees N., 77.7 degrees W.; Dec. 11, 10.7 degrees N., 81.7 degrees W.; Dec. 12, 10.5 degrees N., 83 degrees W. (Monthly Weather Review, Dec. 1887). Author's note: This track was not found to differ significantly from the one in Neumann et al. (1993).

The author of this study is skeptical about the track of this storm because it is difficult to envision how a system so far south could have produced a "norther" along the northern West Indies. However, he could not produce any evidence against the track and, much less, against the existence of the storm itself. Therefore, the track in Neumann et al. (1993) was accepted and reproduced as for Storm 19, 1887 in Fig. 1.

There was no evidence of hurricane intensify and, consequently, the tropical storm status indicated in Neumann et al. (1993) was also accepted.

Special statement.

In addition to the above storms, there were some possible cases which were not included because of uncertainties about whether or not the depression attained storm intensity and/or about the track followed by the disturbance. Three of these possible cases are presented next.

A) Case of Jun. 10-15, 1887.

This case originated off the U.S. Middle Atlantic coast. The following information is connected with this possible case: 1) Map showing a track for the storm starting near 37 degrees N., 73 degrees W. on Jun. 10. Positions for other days were: Jun. 11, 33.3 degrees N., 74.5 degrees W.; Jun. 12, 34 degrees N., 70.8 degrees W.; Jun. 13, 35 degrees N., 69.7 degrees W.; Jun. 14, 40.5 degrees N., 57.3 degrees W.; Jun. 15, 46 degrees N., 37 degrees W. (Monthly Weather Review, Jun. 1887). 2) Steamer "Edith Godden". Jun. 12, lat. 38 10 N., long. 74 15 W.; 1 P.M., barometer 29.98 inches, wind N.N.E. force 6, moderate N. sea and heavy E. swell; 5 P.M. barometer 29.90 inches, wind N.N.E. force 6, heavy N.N.E. sea, very heavy E. and N. swell; 10 P.M., barometer 29.86 inches, wind N. by E. force 7, heavy N. by E. sea, very heavy E.N.E. swell, weather threatening; Jun. 13, 3 A.M., barometer 29.72 inches, wind N. force 9, very heavy N. sea and N.E. by E. swell, steering S., hauled ship's head to W.S.W.; 9 A.M., lat. 35 04 N., long. 75 10 W.,

barometer 29.78 inches, wind N. by W. force 7, sky covered by scud traveling very fast from N. by W.; noon, less wind and sea, sky clearing (Monthly Weather Review, Jun. 1887). 3) Steamship "Manhattan" reported strong N.E. to N.N.E. winds from Jun. 12 to Jun. 16 during a passage from Havana to Winter Quarter Lightship; also she had very heavy confused seas and had to haul in out of the Gulf Stream to get smoother weather as the sea was very high and the vessel shipped much water. Capt. Stevens of the "Manhattan" reported that this was his roughest passage in 17 months (Monthly Weather Review, Jun. 1887). Author's note: This item was primarily linked to another depression of slight depth which was alledged to have appeared in the subtropics to the N. of the West Indies and circled slowly E. of N. until disappearing after Jun. 16. It was indicated, however, that the latter system, in conjunction with the one described here, caused very unsettled weather off the U.S. coast on Jun. 12-16 and this is why this information is included as being related to this storm as well. 4) Steamship "St. Ronans" reported a strong gale commencing from S. at 6 A.M. Jun. 14 (noon position: lat. 47 53 N., long. 37 01 W.) and ending from N.N.W. at noon Jun. 15 in lat. 46 08 N., long. 41 23 W. (Monthly Weather Review, Jun. 1887). 5) Steamship "Devonia" reported a fresh gale on Jun. 14-15; wind hauled from S.W. to S.; lowest barometer 29.30 inches at 4 A.M. Jun. 15 in lat. 42 53 N., long. 57 31 W. (Monthly Weather Review, Jun. 1887). Author's note: 4 A.M. Jun. 14 would fit better the information in item 1). 6) Steamship "Buenos Ayrean" reported a fresh gale on Jun. 15; wind veered from S.S.W. to N.W. at 6:30 P.M.; lowest barometer 29.50 inches at 6 A.M. in lat. 53 26 N., long. 30 06 W. (Monthly Weather Review, Jun. 1887). 7) Ship "Worcester" reported a strong gale on Jun. 15; wind veered from N. to S.; lowest barometer 29.38 inches at 6 P.M. in lat. 49 N., long. 32 W. (Monthly Weather Review, Jun. 1887).

As this storm allegedly moved southward from higher latitudes and then was near the Gulf Stream for several days (item 1), the possibility is there that it might have acquired tropical characteristics, a happening which is sometimes observed in cases similar to this one. This is why this particular system is being mentioned here as a possible storm case.

B) Case of Sept. 1-5, 1887.

The following information was available about this possible case: 1) Brig "Abbie Clifford". Aug. 31, 2:30 P.M., in lat. 25 10 N., long. 80 W., heavy squall from E. with heavy rain and very black weather; the wind died out as the rain ceased. At night the wind increased and at midnight (Aug. 31- Sept. 1) it was blowing from E.N.E. force 8. From Sept. 1 to Sept. 5, between the above position and lat. 28 30 N., long. 80 W., experienced unsettled weather with frequent S.E. and N.E. gales of force 7 to 8 and rain squalls (Monthly Weather Review, Sept. 1887). 2) Bark "Lizzie Carter", from Galveston, reported that the wind set in from E., backing to N.E. and increased to a gale which lasted 8 days. Aug. 31, lat. 31 20 N., long. 77 30 W., passed a large bark abandoned and waterlogged, the sea was breaking over her (The New York Times, Sept. 10, 1887, p.5, col.4). Author's note: It is not clear that the above information pertained to this possible case. 3) Track for this weather system: Sept. 1, 23.5 degrees N., 83 degrees W.; Sept.

2, 24.0 degrees N., 80.5 degrees W.; Sept. 3, 25 degrees N., 80 degrees W.; Sept. 4, 27 degrees N., 79 degrees W.; Sept. 5, 30 degrees N., 77 degrees W. (Monthly Weather Review, Sept. 1887). Author's note: The above mentioned track was extended to 40 degrees N., 48 degrees W. on Sept. 6 and to 53 degrees N., 53 41 degrees W. on Sept. 7, which seems to be a crude mistake.

Although winds of tropical storm intensity (force 8) were reported in item 1), no evidence of westerly winds, implying a closed cyclonic circulation, was found in the available data. Therefore, the validity of the track in item 3) became questionable and this was the main reason to keep this system as a possible storm case.

C) Case of Oct. 22-23, 1887.

The following information allowed one to identify this possible case: 1) The presence of a depression over the ocean between 20 and 25 degrees N., 45 and 50 degrees W, was shown by vessel reports on Oct. 22 and 23, which were not sufficiently numerous in that region to determine its strength and to admit of charting its track previous or subsequent to those days (Monthly Weather Review, Oct. 1887). 2) Map showing a track for this system. Daily positions are: Oct. 22, 23 degrees N., 45 degrees W.; Oct. 23, 24.3 degrees N., 48 degrees W. (Monthly Weather Review, Oct. 1887).

The alleged location and motion of this low pressure area was crucial in considering it as a possible storm case.